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POSSIBLE CONNEXION BETWEEN LARGE SCALE STRUCTURES

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ABSTRACT

From the Lyon-Meudon Extragalactic Database LEDA, we constructed a sample of 27,000 galaxies with radial velocities smaller than $15,000 \text{ km s}^{-1}$. From this first sample we selected the 5,683 largest galaxies which constitute a sample complete up to the diameter limit $D_{25} = 1.6'$. This sub-sample has been used to search for the most populated plane. The result is that the plane defined by the pole ($l = 52 \text{ deg}$; $b = 16 \text{ deg}$) contains twice as many galaxies as would be found for randomly distributed galaxies. This plane is not far from the supergalactic plane.

Then, the distribution of galaxies is studied in this plane by using the radial velocity as an estimate of the distance. An excess of galaxies appears at a distance of about 70 Mpc. We discuss the reality of this density enhancement which could result from selection effects.

Subject headings: galaxies: redshifts - large scale structure of the universe

1 Introduction

Our long-term goal is a study of the kinematics of the local Universe ($z < 0.05$). Such a study is obviously connected with the distribution of galaxies around our Local Super Cluster (LSC). In order to make it easier we searched first for the most populated plane to reduce the study to a 2D case. This is suggested by preliminary results (Bottinelli et al. 1986; Tully 1986) showing that a dominant concentration of galaxies is located in a plane close to the supergalactic one.

The first step is thus the construction of the sample. It is particularly important to get a sample with a well-defined completeness limit in order to study selection effects. For this purpose we used the Lyon-Meudon Extragalactic Database LEDA¹. LEDA is a free access database which has been created in 1983 to collect the main parameters of the principal galaxies. More than 90,000 galaxies are managed with their cross-identifications and observational measurements, including radial velocities and apparent diameters which are the relevant parameters for the present study.

2 The sample

From LEDA, we thus constructed a sample of 27,000 galaxies with radial velocities smaller than $15,000 \text{ km s}^{-1}$. From this first sample we selected the 5,683 largest galaxies (containing all morphological types) which actually constitute a complete sample up to the diameter limit $D_{25} = 1.6'$. The classical test of completeness $\log N$ vs. $\log D_{25}$ (see Paturel et al. 1994) was performed from which we conclude that the sample is complete at a level of 85-90%. It means that 85% of galaxies satisfying both conditions $V < 15000 \text{ km s}^{-1}$ and $D_{25} = 1.6'$ are included in the sample (it does not mean that the sample contains 85% of all existing galaxies within the limiting distance - an impossible task). The major interest in having a sample with such a clear definition is that it makes it possible to predict how many galaxies are expected in a given direction assuming an isotropic distribution, or, how many galaxies are expected at a given distance assuming a homogeneous distribution. The comparison with the actual number will thus allows us to detect possible difference with an homogeneous and isotropic distribution.

¹To connect LEDA enter *telnet lmc.univ-lyon1.fr* login: *leda*

3 The most populated plane

Altering the orientation of a test plane in steps of 1 deg in galactic longitude and latitude, we counted galaxies lying within 15 deg of it. We found that the plane defined by the pole ($l = 52$ deg; $b = 16$ deg), in galactic coordinates, is the most populated one. More precisely, from the covered solid angle one should expect 25% of the total sample within the ± 15 deg limits defining the plane (if one assumes an isotropic distribution of galaxies), while the actual percentage reaches 45%. The conclusion is that the corresponding plane contains most of the local visible masses. It contains the main clusters and superclusters: Perseus-Pisces, Pavo-Indus, Centaurus, Coma and LSC. This plane is close to the supergalactic plane or hypergalactic plane (Paturel et al. 1988). The trace of this plane is shown in a Flamsteed equal area projection (Fig. 1).

The conclusion of this section is that, within the considered volume, the distribution is not isotropic but well concentrated in a dominant plane which will constitute our new reference framework (hereafter, MPP).

4 Distribution of galaxies within the MPP

For each galaxy of the complete sample we define the distance from the heliocentric radial velocity, adopting a Hubble constant of $H=75 \text{ km s}^{-1} \text{ Mpc}^{-1}$. Then, the 5,683 galaxies are plotted in the MPP. The result is shown in Fig. 2. Apart from radial structures (known as "fingers of God") which are obvious artefacts due to the velocity dispersion in clusters, a cocoon-like structure can be seen around the LSC (Di Nella & Paturel 1994). Some parts of it can be recognized as traces of already known structures: e.g. The "Great Wall" (Geller & Huchra 1988), The "Southern Wall" (or Pavo-Indus supercluster) (Da Costa et al. 1988) and the Perseus-Pisces wall (Haynes & Giovanelli, 1986).

In order to conduct a more quantitative analysis we made a histogram of distances of our galaxy sample and compared it with the one predicted from the selection function of a homogeneously distributed sample having the same diameter limit. The result is shown in Fig. 3. A very significant secondary peak appears around $\approx 68 \text{ Mpc}$. The excess of galaxies seen in Fig. 2 is confirmed, but this does not confirm that the cocoon shape is real.

The conclusion of this section is that the distribution of galaxies within the hypergalactic plane does not look homogeneous. Is it real or not? Is it just the result of selection effects? This will be discussed in the last section.

5 Discussion

Several arguments can be given against the reality of the ring-like structure seen in Fig. 2:

- The cocoon is almost centered on our galaxy. This anthropocentric position cannot be accepted.
- The density enhancement in Fig. 3 could be due to some selection effects (e.g. the limiting diameter can be different for field galaxies and cluster galaxies).
- None of the other team working on the Large Scale distribution of galaxies gives similar description.
- The density enhancement of the LSC does not appear on IRAS map suggesting that the LSC does not play a central role as depicted by Fig. 2.

The corresponding counter-arguments are as follows:

- It is not easy to find the center of the cocoon. At least the curved trace of the Great Wall is not centered on our Galaxy. We cannot exclude that the center is in fact on the LSC.
- The density enhancement in Fig. 3 comes from some well established structures which appear to be connected by the cocoon-like structure. We do not suspect that these well-admitted structures result from selection effects.
- The cocoon-like structure can only be found when working with a whole sky sample. It is also most easily visible by viewing a projection of the most populated plane.
- The LSC does exist.

In conclusion, even if the distribution of nearby galaxies looks like an artefact, it is not clear what would be the cause of it.

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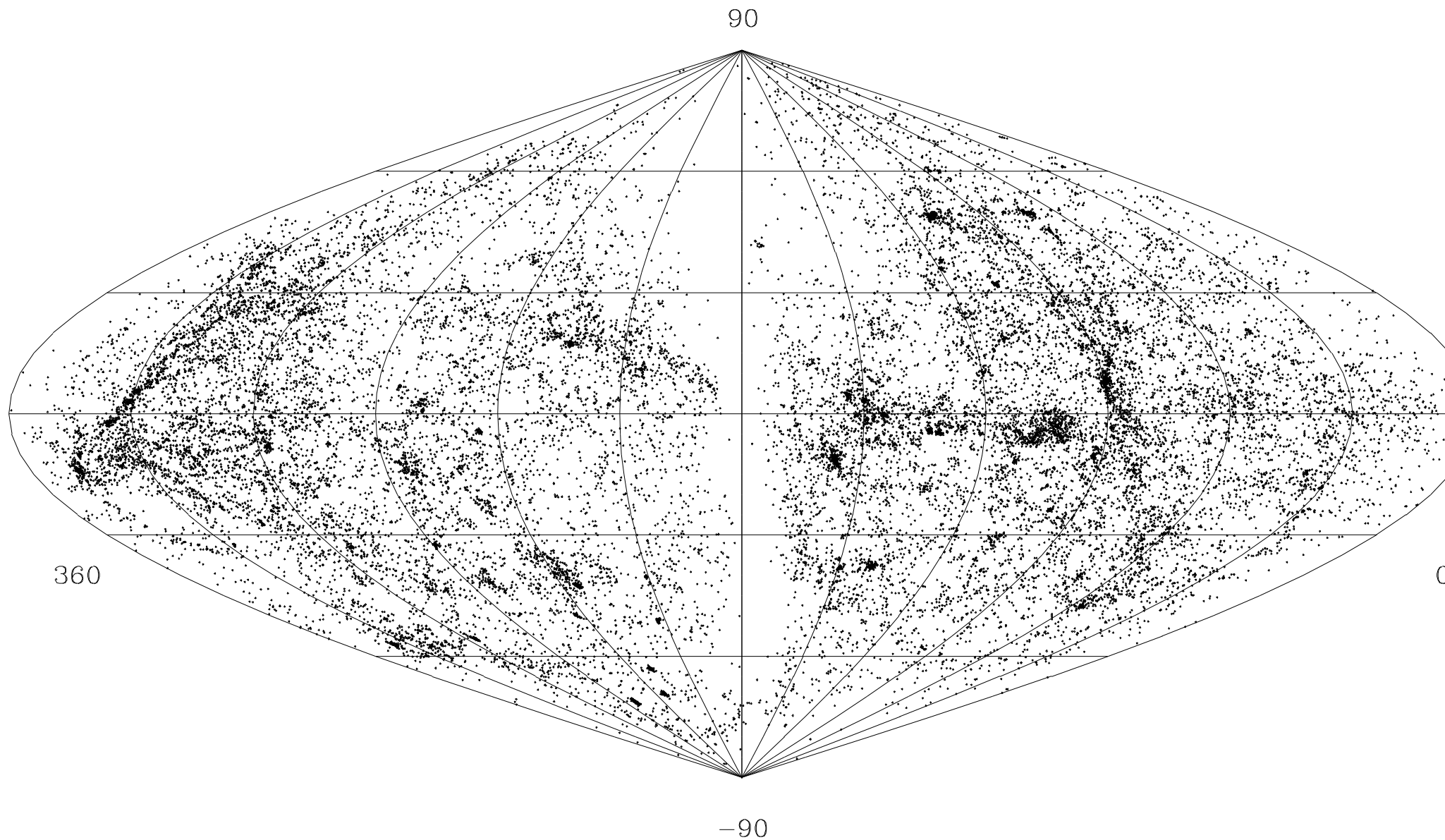
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Figure 1: Flamsteed equal area projection for 27,045 galaxies in supergalactic coordinates. A S-shape shows the trace of the most populated plane: the hypergalactic plane. This plane connects Perseus-Pisces, Pavo-Indus, Centaurus, Coma and Virgo superclusters.

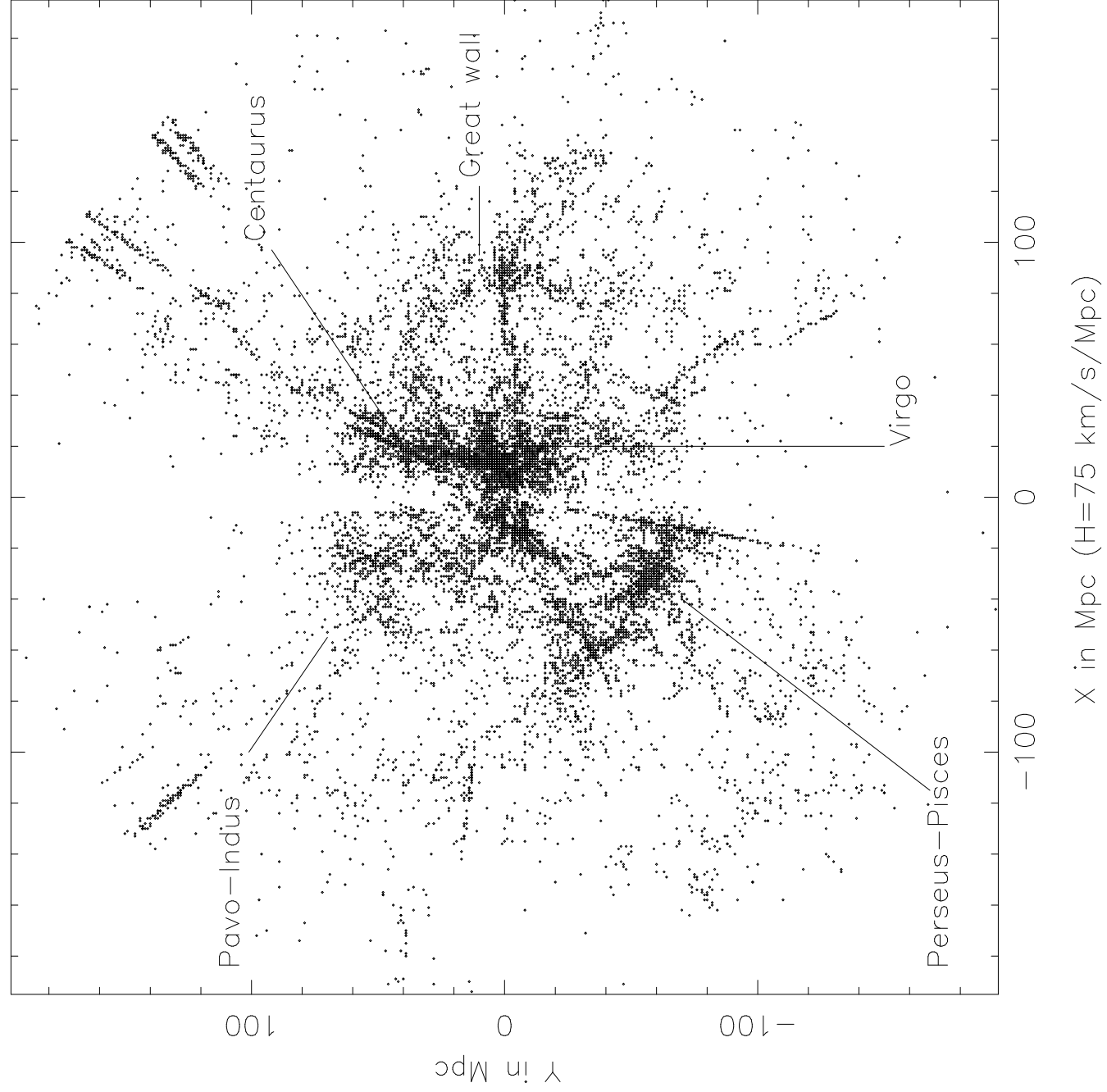
Figure 2: Distribution of the Leda galaxies in the most populated plane.

Figure 3: Histogram of distances around the LSC. A homogeneously distributed sample would have given the dashed line curve.

Flamsteed equal area projection for 27045 galaxies in supergalactic coordinates



LYON MEUDON EXTRAGALACTIC DATABASE



Whole Sample

